JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1993, 60, 595-609 NUMBER 3 (NOVEMBER)

THE EFFECT OF INCREASED RESPONSE REQUIREMENTS ON DISCRIMINATIVE PERFORMANCE OF THE DOMESTIC HEN IN A VISUAL ACUITY TASK

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Six domestic hens were trained in a spatial discrimination task. A controlled reinforcement procedure insured that the ratio of scheduled and obtained reinforcement remained equal. Gray stimuli and gratings ranging in spatial frequency from 1 to 10 cycles per millimeter were presented in seven descending series of probes. The response requirement to the sample key was varied from fixed ratio 1 to fixed ratio 40 in seven experimental conditions. An increase in response requirements from fixed ratio 1 to fixed ratio 5 and fixed ratio 10 resulted in significantly higher accuracy at discriminable grating values. Further increases in response requirements did not consistently improve performance. Generally, response biases increased and occasionally became extreme for probes at finer gratings with increased response requirements.

Key words: discrimination, response requirement, matching to sample, visual acuity, key peck, hens

Visual acuity in animals is often studied by means of a conditional discrimination task in which the animal is required to discriminate between gratings of various spatial frequencies and gray or blank stimuli (e.g., Hodos, Leibowitz, & Bonbright, 1976). This procedure is experimentally analogous to the discrete-trials yes/no signal detection task traditionally used in human psychophysics (Green & Swets, 1966). The matrix of events in this task is illustrated in Figure 1. In the presence of one stimulus (S_1) left-key responses are correct, and in the presence of another stimulus (S_2) right-key responses are correct. The correct responses in the presence of S_1 (w) and S_2 (z) are reinforced intermittently, and the incorrect responses in the presence of S_1 (x) and S_2 (y) result in blackout or have no consequences.

Davison and Tustin (1978) extended the generalized matching law (Baum, 1974) to describe the data obtained from such a task. They suggested that the ratio of choice responses determined by each of the two stimuli (S_1 and S_2) was a power function of the ratio of reinforcers produced by these responses and a function of the discriminability of S_1 and S_2. They proposed two independent measures, log d as a measure of bias due to stimulus discriminability and log c as a measure of bias due to preference for one response alternative over another. (For the derivation of these two measures see Davison & Tustin, 1978, McCarthy, 1983, and McCarthy & Davison, 1980a, 1980b.) When reinforcers for correct responses to both response alternatives are equal, log d, an independent measure free from inherent bias, can be determined as follows:

$$\log d = .5\left[\log\left(\frac{P_w}{P_x}\right) - \log\left(\frac{P_y}{P_z}\right)\right], \quad (1)$$

where P refers to responses and the subscripts refer to the cells of the stimulus–response matrix shown in Figure 1. The better the subject differentiates S_1 from S_2, the larger the log d (discriminability of the stimuli).

A measure of response bias (log c) that includes both reinforcer frequency and inherent bias but is independent of discriminability is determined as follows:

$$\log c = .5\left[\log\left(\frac{P_w}{P_x}\right) + \log\left(\frac{P_y}{P_z}\right)\right]. \quad (2)$$

The Davison and Tustin (1978) model of signal detection has been used to analyze such psychophysical data as luminance difference thresholds in pigeons (McCarthy, 1983) and auditory (Temple, Foster, & O'Donnell, 1984) and visual acuity thresholds in domestic hens (DeMello, Foster, & Temple, 1992).

This research was carried out by the first author in partial fulfillment of the requirements for the doctoral degree. We thank the students who helped conduct this experiment and the technical staff for their assistance. Reprint requests may be sent to Lesley R. DeMello, Department of Psychology, Ballarat University College, P.O. Box 663, Ballarat, Victoria 3350, Australia.

Stimulus	Response: Left	Response: Right
S1 GRATING Present	**W** (correct)	**X** (incorrect)
S2 GREY Present	**Y** (incorrect)	**Z** (correct)

Fig. 1. The stimulus–response matrix of the signal-detection procedure. The entries in the cells represent the four possible outcomes of any trial, where *w* refers to correct left-key responses and *x* refers to incorrect right-key responses on grating trials, and *y* refers to incorrect left-key responses and *z* refers to correct right-key responses on gray-stimulus trials.

On difficult conditional discrimination tasks, one procedural manipulation that improves performance is the requirement of more than one response to the sample key. This type of requirement is common in matching to sample (e.g., Cumming & Berryman, 1961). This is a conditional discrimination procedure in which the correct response alternative is contingent upon the prior presentation of a particular sample stimulus. Farthing and Opuda (1974) reported that pigeons in a matching-to-sample task performed very poorly if they were required to peck only once at the sample, but accuracy improved when they were required to peck 10 times.

These requirements to the sample stimulus are termed fixed ratio (FR) response requirements. Some studies have found that an increase from an FR 1 to an FR 5 response requirement increased discrimination of color (e.g., White, 1985), whereas others have reported that a response requirement greater than FR 5 was necessary to improve accuracy (Berryman, Cumming, & Nevin, 1963). The response requirement that results in the best discriminative performance for any group of subjects has varied across studies up to FR 40, as reported by Sacks, Kamil, and Mack (1972).

The reinforcement schedule has also been reported to affect discriminative performance when subjects are required to respond on each discrete trial. Accuracy was found to increase with the temporal proximity of the next reinforcer (Nevin, 1967). Nevin and MacWilliams (1983) reported that, when responses of pigeons discriminating between two different keylight durations were reinforced each fifth correct response, accuracy increased systematically as a function of the ratio.

Although various behavioral studies of visual acuity in nonhumans have involved the use of a response requirement of FR 3 (e.g., P. Blough, 1971) or greater (e.g., Hodos et al., 1976), none have investigated the effect of varying response requirements on performance in such a task. This was the aim of the present study.

METHOD

Subjects

Six domestic hens (Ross Tinted), numbered 71 to 76, were maintained at 80% ± 20 g of their free-feeding body weights. All birds had previously served in a spatial discrimination task.

Apparatus

The apparatus was identical to that described by DeMello et al. (1992). The standard experimental chamber contained three back-illuminated clear plate glass response keys. Pecks on these keys were effective only if they exceeded a force of 1.5 N for the center key and 0.75 N for the side keys (and closed a microswitch) and if the keys were back illuminated. An effective peck extinguished the keylight and produced a tone for 35 ms. Experimental events were controlled by a Commodore® 64 computer that was situated remote from the experimental chamber.

The target stimuli consisted of a series of pairs of gratings and gray stimuli, as described in DeMello et al. (1992). The gratings ranged in spatial frequency from 1 to 10 line-spaces (cycles) per millimeter (c/mm). Six pairs of gray stimuli and gratings of one spatial frequency were mounted in alternating order around the circumference of an opaque perspex disk (216 mm diameter) located at the rear of the center key. The percentage of contrast of the gratings, as described by DeMello et al. (1992), varied from 92.5% to 100% and was not related to the grating spatial frequency.

Key luminances were 3.48 cd/m^2 for the center sample key and 2.69 cd/m^2 for the two side keys. Luminances of gratings and gray stimuli were equal, with a loss of luminance of 0.155 cd/m^2 at the finest grating (10 c/mm) only. The three response keys were rear illuminated by 3.75-W projector bulbs, and illumination of the walls and ceiling remained at approximately 3 lux. An automatic food hopper contained whole wheat.

Procedure

Six gratings of the same spatial frequency and six gray stimuli were presented during an experimental session. Stimulus presentation was pseudorandom, using a variation of the Gellerman (1933) series. This insured that the grating and gray stimuli would each be presented on no more than three consecutive trials, and that each would be presented on approximately the same number of trials within each experimental session. A noncorrection procedure was used.

Food reinforcers were delivered on a variable-interval (VI) 30-s schedule using a version of the Gellerman (1933) series. The VI schedule consisted of an arithmetic series of 15 intervals presented in random order.

A controlled reinforcement procedure (McCarthy & Davison, 1980a) was used. This procedure, translated into the signal detection procedure by Stubbs (1976) from concurrent-schedule research (Stubbs & Pliskoff, 1969), insures equality between the obtained and scheduled reinforcer ratios. When a reinforcer is arranged for one of the responses, the schedule associated with the other correct response stops until the arranged reinforcer has been obtained.

Each trial began with the presentation of either a grating or a gray stimulus (the sample stimulus) behind the illuminated center key. A single peck on this key resulted in the two side keys being lit. If the grating was present behind the center key, a peck to the left side key was correct. If the gray stimulus was presented on the center key, a right side key peck was correct. The center response key remained lit during this choice. A correct trial resulted in illumination of the magazine light for 3 s; this was accompanied aperiodically by 3-s access to wheat. During reinforcement, the three keylights were extinguished and the keys were inoperative. Incorrect responses (i.e., a response to the right key when a grating was presented or a response to the left key when a gray stimulus was presented) resulted in 3-s blackout. During reinforcement or blackout, the stimulus disk turned to position the stimulus for the following trial. Sessions started and ended in blackout. Sessions were scheduled for 7 days a week and lasted for 45 reinforcers or 30 min, whichever occurred first. Preliminary and general training procedures for the first condition have been described by DeMello et al. (1992).

The present study included seven conditions that involved manipulation of the sample-key response requirement. For the first six consecutive conditions, response requirements were FR 1, FR 5, FR 10, FR 15, FR 25, and FR 40, in that order. For the final condition, the response requirement was decreased to FR 1. Data from Condition 1 (FR 1) have been reported by DeMello et al. (1992). They are included in this study only as a baseline to allow a comparison of performance across the different conditions. A return to FR 1 in Condition 7 provided a control for any practice effects resulting from performance at higher response requirements.

At the beginning of each condition, hens were trained to accuracy and stability criteria as in the study of DeMello et al. (1992). Hens were required to respond with 80% accuracy on total (both grating and gray) trials. It was necessary to reduce this criterion to 70% accuracy for Hen 73, when it became apparent, after extensive training, that she was not going to reach 80% accuracy. The stability criterion required that the median of the proportion of correct responses emitted over five sessions be within .05 of the median from the preceding five sessions (Davison, 1976). This criterion had to be met five (not necessarily consecutive) times. Table 1 presents the seven conditions and the number of sessions to stability.

Once the above criteria were satisfied, hens completed a descending series of probes. That is, the gratings presented in each probe session were increased in spatial frequency (i.e., progressively finer gratings) from 1 c/mm to 10 c/mm. Only one value of grating was used during a probe session, and only one probe session was undertaken at each grating value.

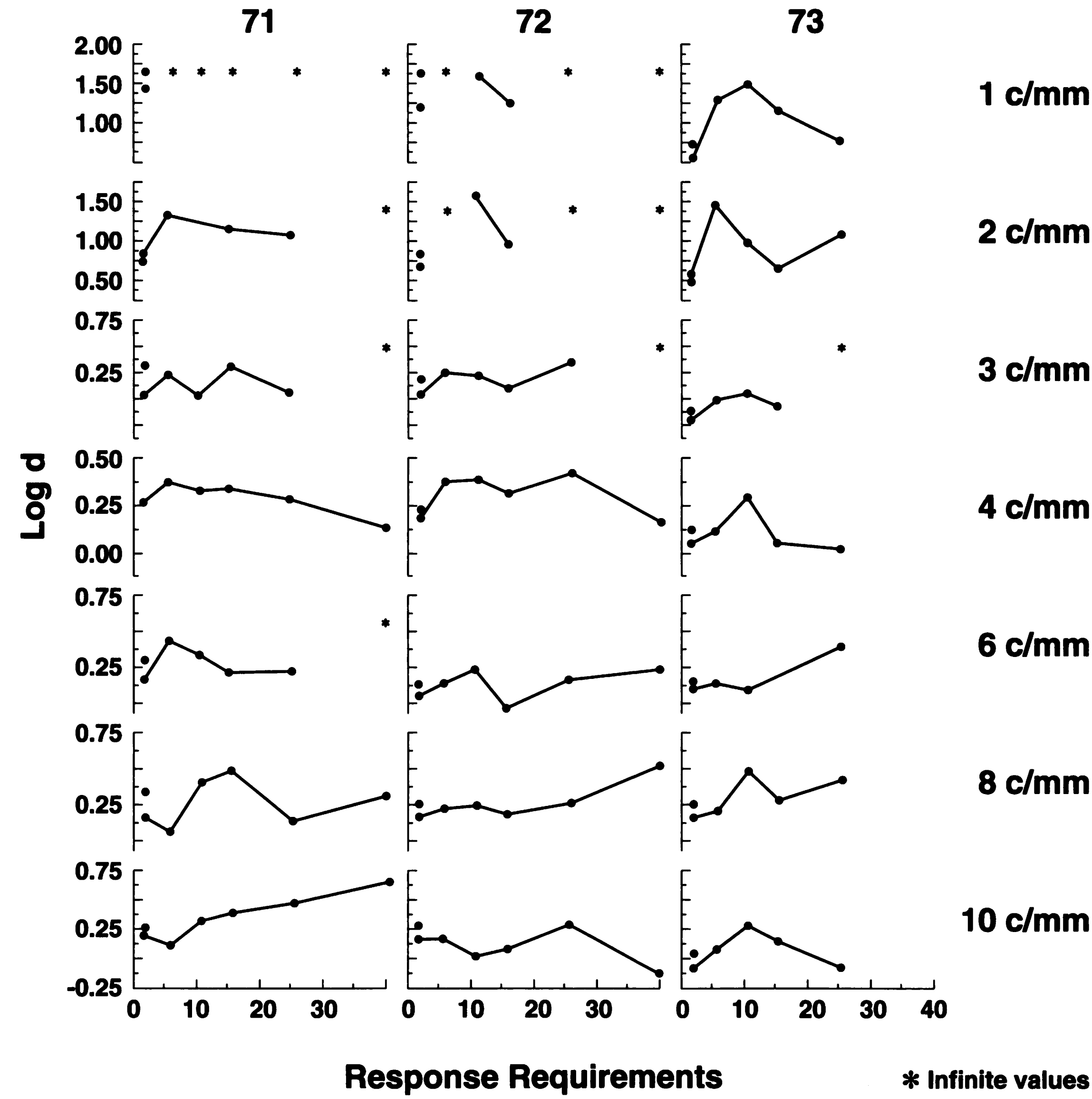

Fig. 2. Values of log *d* plotted as a function of response requirements for each hen. A separate plot is shown for each grating spatial frequency. Data for the FR 1 to FR 40 response requirements (Conditions 1 to 6) are joined by a solid line. Data for FR 1 (Condition 7) are plotted separately. Asterisks denote infinite values.

Reinforcement delivery continued during probe sessions. Between probe sessions, training continued with the coarsest grating (1 c/mm) for at least one session until each hen had again reached her individual testing criterion: that correct response proportions be within .1 of the highest proportion of total trials correct during the last 5 days of training before the probe series began.

Data collection. Data included the number of correct and incorrect responses to the left and right keys following presentation of the grating and gray stimuli on the sample key and the number of reinforcers obtained for responding correctly on the left and right keys.

RESULTS

Figure 2 presents values of log *d* (Equation 1) as a function of FR response requirements,

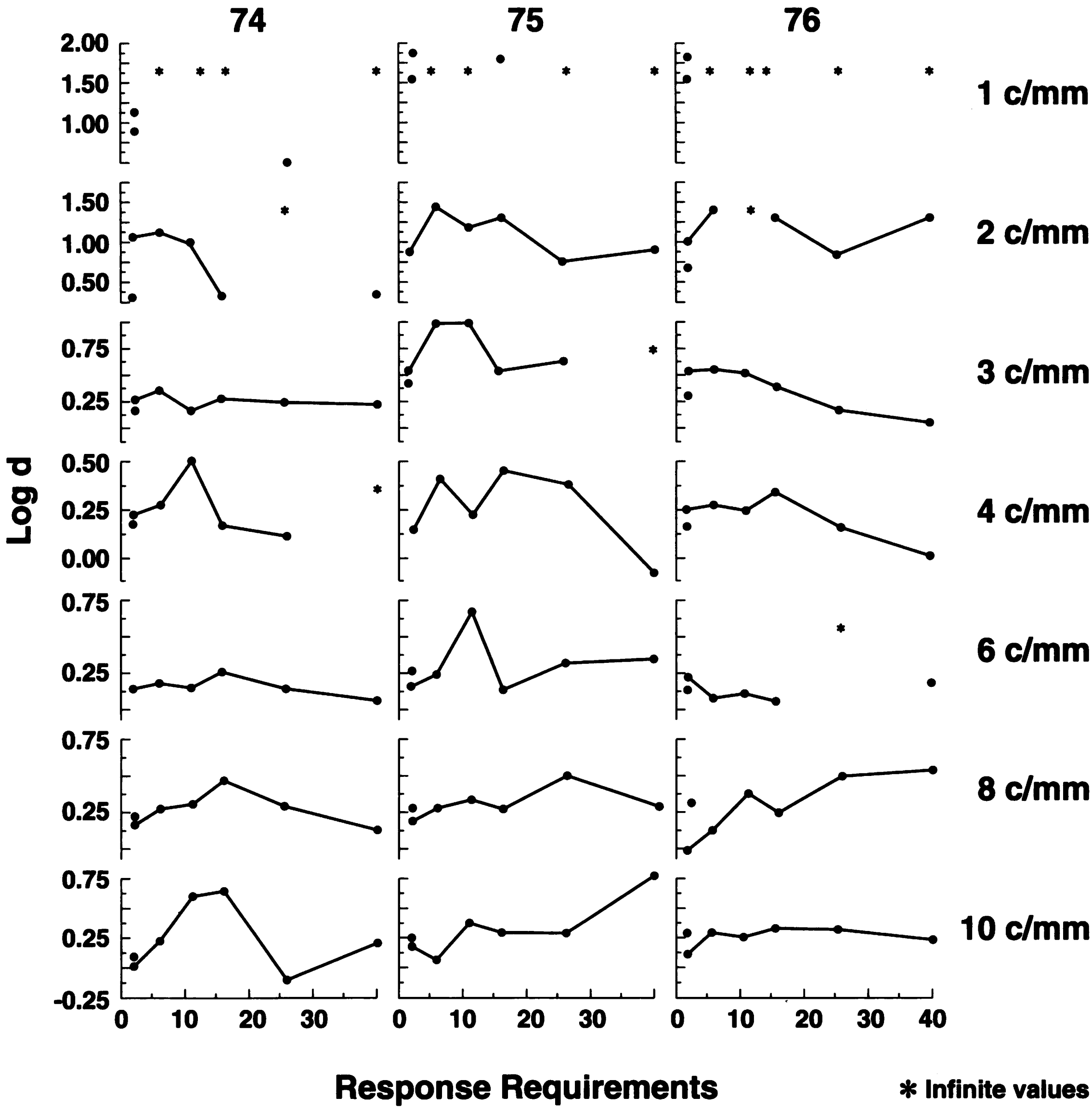

Fig. 2. Continued.

with separate functions for each of the grating spatial frequencies, for each hen. Data for the first six successive conditions are joined by a solid line. A separate point is plotted for FR 1, Condition 7. Where log *d* values are infinite and cannot be plotted, an asterisk is shown.

Figure 2 allows a comparison of the effect of each of the response requirements on discriminative performance at each grating spatial frequency. At the 1 c/mm grating spatial frequency, most log *d* values are infinite at probes with response requirements greater than FR 1. These infinite values result from an absence of responses in one of the four cells of the stimulus–response matrix (Figure 1) and, at the coarser gratings, indicate perfect performance in the presence of one or both stimuli. No infinite values were obtained at this grating spatial frequency for Hen 73, who consistently provided the least accurate performance. An infinite log *d* value is plotted for this hen's performance at the 3 c/mm grating spatial

Table 1

The experimental conditions, the response requirement in effect for each condition, and the number of training sessions in stability prior to commencement of the probe series for each condition.

Condition	Response requirement	Sessions to stability
1[a]	1	21
2	5	14
3	10	13
4	15	17
5	25	32
6	40	19
7	1	13

[a] DeMello et al. (1992).

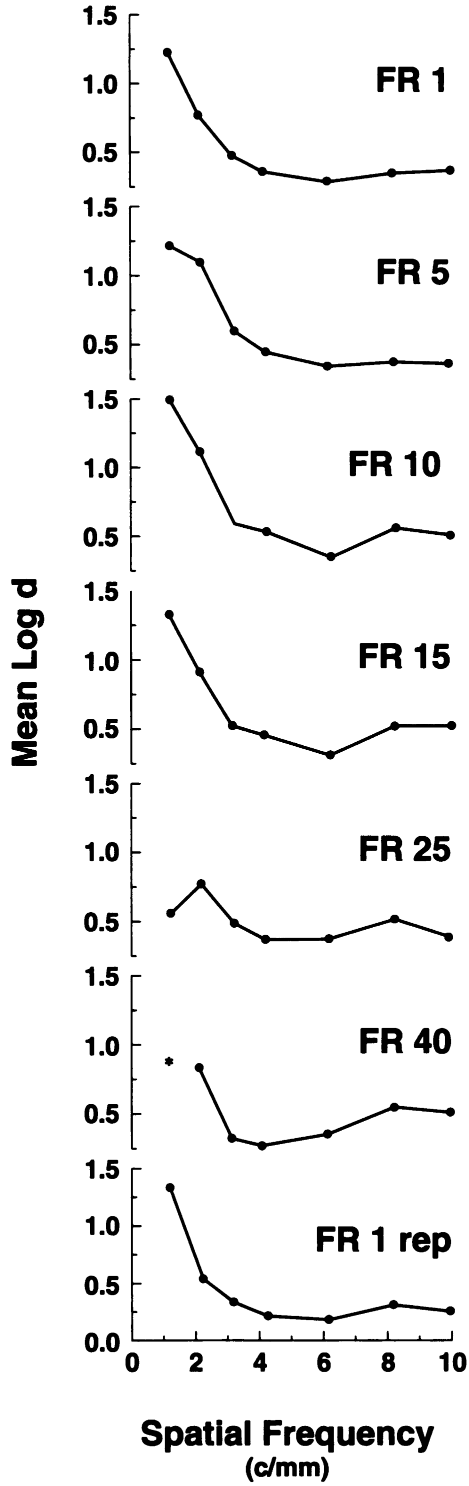

Fig. 3. Mean values of log d plotted as a function of grating spatial frequency for each response requirement. A solid line joins data from successive probes.

frequency with the FR 25 response requirement because of an absence of left-key responses (or exclusive right-key response bias).

Values of log d at stimulus values from 1 to 4 c/mm increased with FR 5 and FR 10 response requirements for most hens. The greatest improvement in stimulus discriminability, compared with performance in either of the two FR 1 conditions, occurred when the FR 5 response requirement was in effect. For this condition, 88% of the log d values were greater at the discriminable grating spatial frequencies, compared to 71% improvement with FR 10 and only 50% to 63% improvement when response requirements were further increased.

Using the Wilcoxon signed-rank test, log d values for each hen from probes with the FR 1 response requirement (either Condition 1 or 7, whichever was the greater) were compared to log d values with the FR 5 response requirement for the same grating spatial frequency. This was repeated, comparing the greater log d values from FR 1 to those obtained with each of the increased response requirements. Only the log d values for grating spatial frequencies of 1, 2, 3, and 4 c/mm were compared, because performance at higher grating spatial frequencies indicated that these stimuli were indiscriminable. Performance with the FR 5 response requirement was statistically significantly more accurate than with FR 1, at the .01 level. Accuracy with the FR 10 response requirement was statistically significantly greater than with FR 1 at the .05 level. Although the data show that performance for some individual hens continued to improve at various grating spatial frequencies with greater response requirements, this result was not consistent.

During training sessions with the FR 40 response requirement, Hen 73's accuracy decreased, and responding stopped prior to probes. As a result, no probe data were obtained for this hen at the FR 40 response requirement (Condition 6). Hen 73 resumed responding during retraining with the FR 1 response requirement.

Figure 3 presents the mean values, averaged across subjects, of log *d* plotted as a function of grating spatial frequency for each response requirement. In general, the log *d* values decreased monotonically as a function of grating spatial frequency, leveling off at probes with increasingly finer gratings. In some conditions, accuracy seemed to increase at some probes with finer gratings. Data for the 1 c/mm grating value with the FR 40 response requirement could not be plotted because, for all 5 hens that completed that condition, log *d* was infinite. Five of the 6 hens obtained infinite log *d* values for probes at the coarsest grating with FR 5. The datum point plotted in Figure 3 is from Hen 73, whose performance was generally the least accurate. The atypical shape of the function from probes with the FR 25 response requirement resulted mainly from the inaccurate responses of 2 hens (73 and 74) during a small number of trials at the coarsest grating. A comparison of the descending portion of the functions indicates greater log *d* values for conditions with response requirements greater than FR 1.

Figure 4 shows an estimate of response bias, log *c* (Equation 2), plotted as a function of response requirements for each grating spatial frequency for each hen. (Infinite log *c* values are indicated by asterisks.) Data for the first six conditions are joined by a solid line. Data for FR 1 (Condition 7) are shown as a separate point. Positive log *c* values indicate more left-key responding (as though the stimuli were gratings), and negative values indicate more right-key responding (as though the stimuli were gray). A comparison of the log *c* values from the two FR 1 conditions with those for performance with the increased response requirements for all spatial frequencies indicated that, although there was an increase in right-key bias, these changes were not sufficiently consistent to be significant. Infinite log *c* values at the finer grating values indicate exclusive responding to one response alternative. Although this did not occur at probes with the FR 1 response requirement at any grating spatial frequency, it did occur at grating values of 3, 4, and 6 c/mm when the greater FR response requirements were in effect. Perusal of the raw data shows that this exclusive responding occurred on the right key only, and occurred despite the use of a controlled reinforcement procedure that penalized the hen by loss of overall reinforcement for such behavior. In fact, in cases of exclusive preference, only one food delivery (at most) could occur in a session.

DISCUSSION

The important finding in the present study was that stimulus discriminability changed with changes in the response requirement to the sample key. In general, discrimination improved at stimulus values of 1 to 4 c/mm when the FR 5 and FR 10 response requirements were in effect, compared to performance with FR 1 from either the first or last condition. These results agree with those of several studies in which an increase from a single response to multiple responses to the sample resulted in increased accuracy in various discrimination tasks (e.g., Honig & Urcuioli, 1981; Roberts, 1972; Sacks et al., 1972).

Changes in discriminability at response requirements greater than FR 10 were not the same for all hens. For some, accuracy increased further; for others, the accuracy attained at FR 10 was maintained; and for the rest, accuracy decreased. Other studies (e.g., Lydersen, Perkins, & Chairez, 1977) have also found variations in discriminative performance between pigeons at different response requirements.

Any improvement in accuracy at discriminable gratings would change the slope of the psychophysical function and result in changes in absolute thresholds. The response requirement, therefore, provides yet another nonsensory variable to be taken into account in psychophysical investigations.

Research on attentional mechanisms has given some theoretical status to the notion that multiple responding can be a strong discriminative cue. Honig and Urcuioli (1981) reviewed studies of stimulus generalization in which multiple responses to the training stim-

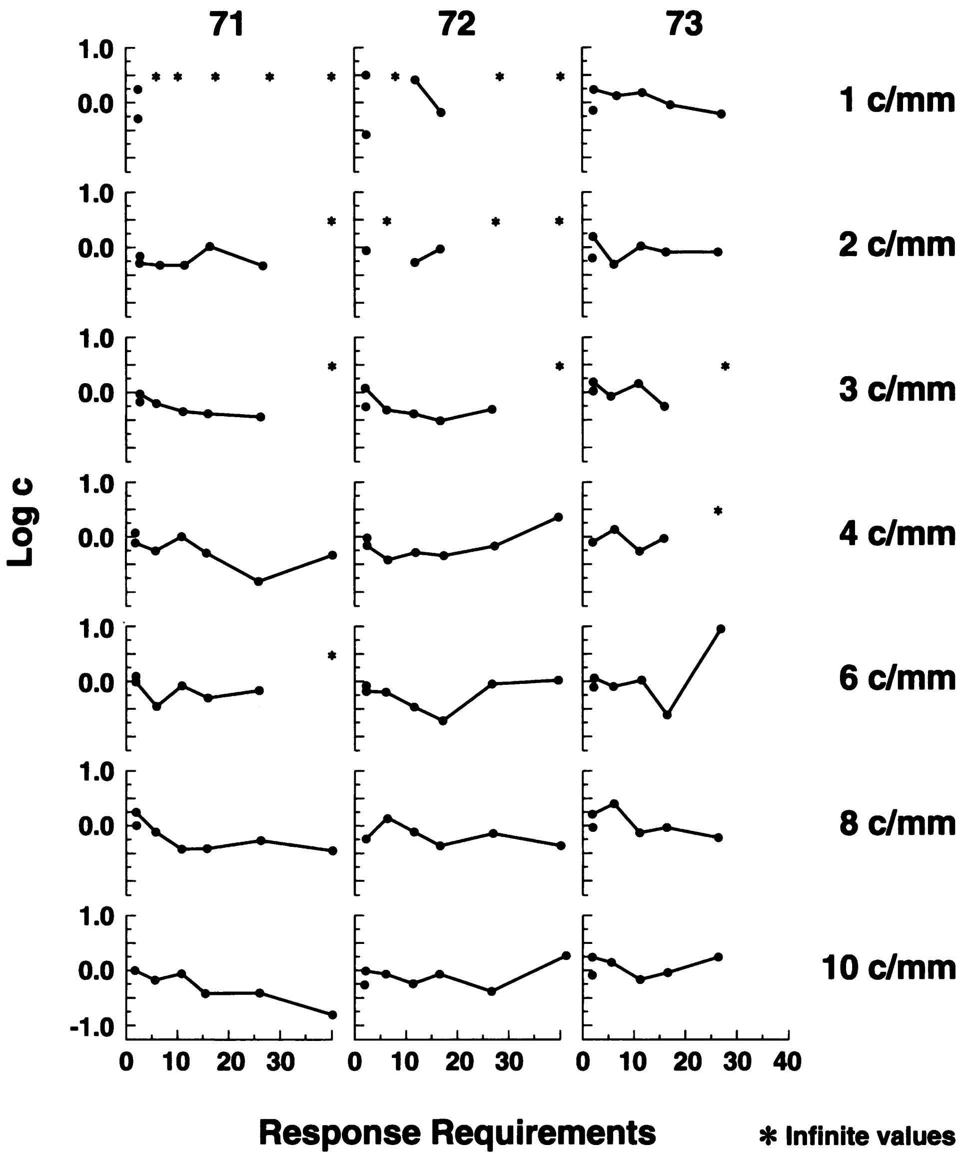

Fig. 4. Values of log c plotted as a function of response requirements for each hen. A separate plot is shown for each grating spatial frequency. Data for the FR 1 to FR 40 response requirements (Conditions 1 to 6) are joined by a solid line. Data for FR 1 (Condition 7) are plotted separately. Asterisks denote infinite values.

ulus resulted in greater discrimination. They suggested that attention to the stimulus dimension under investigation is enhanced through repetitive responding by reducing competition from other stimuli.

Increased response requirements are closely linked with increased stimulus durations. Greater stimulus control, as measured by steeper stimulus gradients, was reported by Beale and Winton (1970) when pigeons could control the amount of time spent in the presence of the training stimulus. Any increase in response requirement also increases the duration of stimulus presentation.

Any increase in the response requirement also involves an increase in effort on each trial. D. Blough (1966) suggested that increased effort and punishment may work in similar ways to improve stimulus control. He argued that rats look before they run when shock accom-

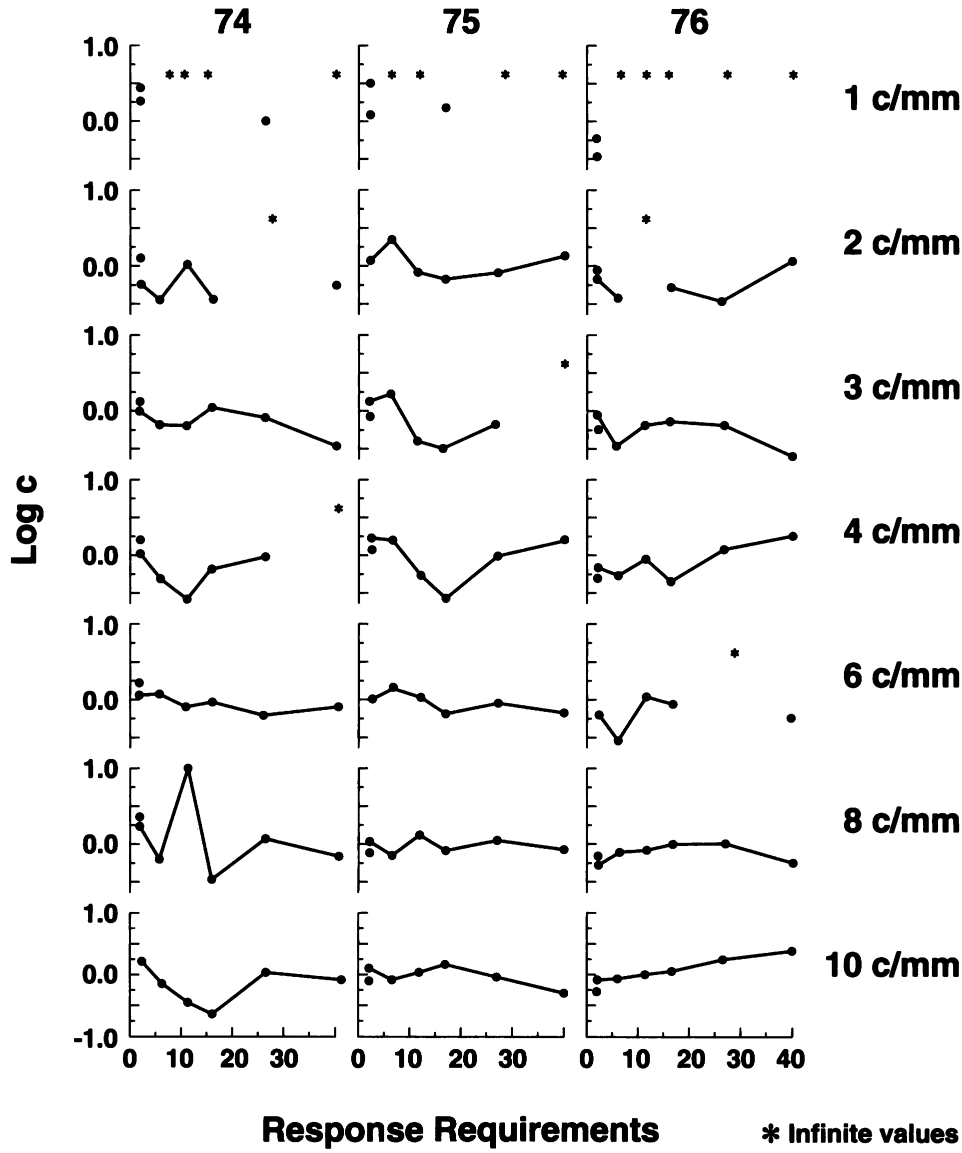

Fig. 4. Continued.

panies incorrect responses. In the present study, the hens may have paid more attention before responding when each trial involved multiple responses, because errors became more costly.

In the present study, the effects of increasing the response requirement may have been confounded with another variable—the reinforcement schedule. The trial duration increased as a function of increased response requirement. Because a VI reinforcement schedule was in effect, the number of correct trials per reinforcement decreased. On average, with the FR 1 response requirement the hens' responses were reinforced about every seventh trial, but when the FR 5 was in effect responses were reinforced about every fourth trial on average. Past research indicates that discrimination is directly related to the temporal proximity of the reinforcer (Nevin & MacWilliams, 1983) and increased reinforcement density (Hearst, Koresko, & Poppen, 1964). However, very large response requirements may be aversive in a way similar to that of very long FR reinforcement schedules. The aversive effects of long FR reinforcement schedules have been well documented (e.g., Azrin, 1961; Gentry, 1968; Zimmerman & Ferster, 1963).

Although attentional enhancement and increased reinforcement probability may account for improved discrimination at coarser gratings with increased response requirements, it is more difficult to account for the increased response bias at finer gratings. The controlled reinforcement procedure typically maintains responding to both alternatives and helps to prevent exclusive responding to one alternative (McCarthy & Davison, 1984). The present results, however, indicate that although the controlled reinforcement procedure may act as a constraint to the development of response biases at indiscriminable stimulus values when FR 1 is used, these constraints are less effective when greater response requirements are in effect. Because infinite values of log c did not occur when single response requirements were in effect on the sample, it seems that the increased, and occasionally extreme, right-key response biases were a function of the multiple-response requirement, rather than a gradual change in the overall pattern of responding.

The slight increase in accuracy for some hens at the finest grating values has been discussed by DeMello et al. (1992) and has also been reported by Hodos et al. (1976), using a similar procedure with pigeons in a visual acuity task. Millodot (1973) suggested that this "spurious resolution" results from occasional detection of wavy edges of fine grating stimuli that may act as cues.

In summary, the increased response requirements, FR 5 and FR 10, resulted in improved accuracy at discriminable grating values when compared to performance under FR 1. Response biases increased when a multiple-response requirement was in effect, sometimes to the point of exclusivity. Discriminability of the stimulus was a function of the difference between the two stimuli (grating and gray) and, to a limited extent, a function of increased response requirements at the coarser, discriminable gratings. There seems to be an interaction between the stimulus dimension and other nonsensory variables, such as reinforcement probability, effort, and attentional enhancement.

REFERENCES

Azrin, N. H. (1961). Time-out from positive reinforcement. *Science,* **133,** 382–383.

Baum, W. M. (1974). On two types of deviation from the matching law: Bias and undermatching. *Journal of the Experimental Analysis of Behavior,* **22,** 231–242.

Beale, I. L., & Winton, A. S. W. (1970). Inhibitory stimulus control in concurrent schedules. *Journal of the Experimental Analysis of Behavior,* **14,** 133–137.

Berryman, R., Cumming, W. W., & Nevin, J. A. (1963). Acquisition of delayed matching in the pigeon. *Journal of the Experimental Analysis of Behavior,* **6,** 101–107.

Blough, D. S. (1966). The study of animal sensory processes by operant methods. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application* (pp. 345–379). New York: Appleton-Century-Crofts.

Blough, P. M. (1971). Visual acuity in the pigeon for distant targets. *Journal of the Experimental Analysis of Behavior,* **15,** 57–67.

Cumming, W. W., & Berryman, R. (1961). Some data on matching behavior in the pigeon. *Journal of the Experimental Analysis of Behavior,* **4,** 281–284.

Davison, M. C. (1976). Preference for fixed-interval schedules: Effects for unequal initial links. *Journal of the Experimental Analysis of Behavior,* **25,** 371–376.

Davison, M. C., & Tustin, R. D. (1978). The relation between the generalized matching law and signal-detection theory. *Journal of the Experimental Analysis of Behavior,* **29,** 331–336.

DeMello, L. R., Foster, T. M., & Temple, W. (1992). Discriminative performance of the domestic hen in a visual acuity task. *Journal of the Experimental Analysis of Behavior,* **58,** 147–157.

Farthing, G. W., & Opuda, M. J. (1974). Transfer of matching-to-sample in pigeons. *Journal of the Experimental Analysis of Behavior,* **21,** 199–213.

Gellerman, L. W. (1933). Chance orders of alternating stimuli in visual discrimination experiments. *Journal of Genetic Psychology,* **42,** 206–208.

Gentry, W. D. (1968). Fixed-ratio schedule induced aggression. *Journal of the Experimental Analysis of Behavior,* **11,** 813–817.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics.* New York: Wiley.

Hearst, E., Koresko, M. B., & Poppen, R. (1964). Stimulus generalization and the response-reinforcement contingency. *Journal of the Experimental Analysis of Behavior,* **7,** 369–380.

Hodos, W., Leibowitz, R. W., & Bonbright, J. C., Jr. (1976). Near-field visual acuity of pigeons: Effects of head location and stimulus luminance. *Journal of the Experimental Analysis of Behavior,* **25,** 129–141.

Honig, W. K., & Urcuioli, P. J. (1981). The legacy of Guttman and Kalish (1956): 25 years of research on stimulus generalization. *Journal of the Experimental Analysis of Behavior,* **36,** 405–445.

Lydersen, T., Perkins, D., & Chairez, H. (1977). Effects of fixed-ratio sample and choice response requirements upon oddity matching. *Journal of the Experimental Analysis of Behavior,* **25,** 97–101.

McCarthy, D. (1983). Measures of response bias at minimum-detectable luminance levels in the pigeon.

Journal of the Experimental Analysis of Behavior, **39**, 87–106.

McCarthy, D., & Davison, M. (1980a). Independence of sensitivity to relative reinforcement rate and discriminability in signal detection. *Journal of the Experimental Analysis of Behavior*, **34**, 273–284.

McCarthy, D., & Davison, M. (1980b). On the discriminability of stimulus duration. *Journal of the Experimental Analysis of Behavior*, **33**, 187–211.

McCarthy, D., & Davison, M. (1984). Isobias and alloisobias functions in animal psychophysics. *Journal of Experimental Psychology: Animal Behavior Processes*, **10**, 390–409.

Millodot, M. (1973). Influence of the subject's criterion on the visual resolution of a grating. *Perceptual and Motor Skills*, **36**, 155–158.

Nevin, J. A. (1967). Effects of reinforcement scheduling on simultaneous discrimination performance. *Journal of the Experimental Analysis of Behavior*, **10**, 251–260.

Nevin, J. A., & MacWilliams, S. (1983). Ratio reinforcement of signal detection. *Behaviour Analysis Letters*, **3**, 317–324.

Roberts, W. A. (1972). Short-term memory in the pigeon: Effects of repetition and spacing. *Journal of Experimental Psychology*, **94**, 74–83.

Sacks, R. A., Kamil, A. C., & Mack, R. (1972). The effects of fixed-ratio sample requirements on matching to sample in the pigeon. *Psychonomic Science*, **26**, 291–293.

Stubbs, D. A. (1976). Response bias and the discrimination of stimulus duration. *Journal of the Experimental Analysis of Behavior*, **25**, 243–250.

Stubbs, D. A., & Pliskoff, S. S. (1969). Concurrent responding with a fixed relative rate of reinforcement. *Journal of the Experimental Analysis of Behavior*, **12**, 887–895.

Temple, W., Foster, T. M., & O'Donnell, C. S. (1984). Behavioral estimates of auditory thresholds in hens. *British Poultry Science*, **25**, 287–293.

White, K. G. (1985). Characteristics of forgetting functions in delayed matching to sample. *Journal of the Experimental Analysis of Behavior*, **44**, 15–34.

Zimmerman, J., & Ferster, C. B. (1963). Intermittent punishment of S^{Δ}. *Journal of the Experimental Analysis of Behavior*, **6**, 349–356.

Received July 23, 1990
Final acceptance June 20, 1993

APPENDIX

The grating value measured in c/mm (Gtg), the number of correct responses to the left key (CL) and incorrect responses to the right key (IR) on grating trials, the number of incorrect responses to the left key (IL) and correct responses to the right key (CR) on gray-stimulus trials, and the number of reinforcements for correct left-key (L) and right-key (R) responses. Headings show the hen number, condition, and response requirement in effect. Data for the last 5 days of training at the coarsest grating (1 c/mm) at the beginning of each condition are shown. Data for 5 days' training with FR 1 following each condition with an increased FR are also shown (Return to FR 1).

Gtg	CL	IR	IL	CR	L	R
Hen 71 Condition 1 (FR 1)						
1	143	6	9	141	24	20
1	142	8	10	141	22	20
1	149	8	12	143	21	22
1	147	6	14	140	20	23
1	136	15	3	146	22	23
2	104	48	15	135	22	20
3	77	70	48	98	17	19
4	72	79	41	111	18	20
6	71	81	60	89	19	18
8	108	54	79	81	21	20
10	87	73	61	100	21	20
Hen 71 Condition 2 (FR 5)						
1	107	0	3	105	19	20
1	108	0	1	109	21	22
1	109	1	0	109	19	20
1	107	0	1	104	22	20
1	101	0	1	101	19	19
2	90	10	2	97	18	20
3	60	42	18	83	19	16
4	48	47	17	77	17	19
6	38	52	11	81	15	15
8	33	55	34	54	14	16
10	35	46	28	53	16	13
Return to FR 1						
1	150	5	11	145	21	23
1	160	4	9	153	23	21
1	155	1	8	149	21	22
1	151	2	6	149	24	21
1	153	2	2	154	21	23

Gtg	CL	IR	IL	CR	L	R
Hen 72 Condition 1 (FR 1)						
1	134	11	14	132	22	21
1	145	1	9	139	24	21
1	143	0	23	120	23	20
1	144	0	26	116	20	22
1	138	5	24	117	21	21
2	110	42	27	126	23	21
3	89	63	53	100	20	21
4	78	82	55	103	17	18
6	56	102	61	95	18	19
8	67	86	52	103	18	22
10	75	77	57	96	19	18
Hen 72 Condition 2 (FR 5)						
1	91	2	1	90	20	19
1	94	0	1	93	22	19
1	89	2	5	84	19	21
1	90	2	0	92	19	21
1	92	1	0	90	20	19
2	94	8	0	103	18	18
3	53	47	13	89	17	16
4	44	47	16	74	18	17
6	41	64	34	69	16	15
8	52	38	32	55	15	15
10	45	50	31	64	17	16
Return to FR 1						
1	123	16	14	127	21	22
1	138	11	8	134	22	20
1	128	19	2	143	19	22
1	141	11	7	144	22	23
1	139	8	8	139	20	23

Gtg	CL	IR	IL	CR	L	R
Hen 73 Condition 1 (FR 1)						
1	105	44	57	94	19	19
1	123	33	60	98	20	22
1	96	44	60	81	18	18
1	103	46	73	80	19	20
1	117	39	57	99	23	20
2	101	53	74	81	19	16
3	69	78	81	65	17	17
4	62	101	63	100	16	16
6	58	72	56	74	16	14
8	50	37	41	44	10	9
10	30	29	37	24	7	6
Hen 73 Condition 2 (FR 5)						
1	83	5	9	80	17	19
1	87	6	9	85	18	19
1	90	5	8	87	21	22
1	81	5	4	80	20	18
1	60	3	5	58	14	14
2	63	33	11	82	19	17
3	35	39	25	49	13	14
4	46	45	41	48	16	14
6	43	58	37	66	14	16
8	28	14	24	19	6	5
10	44	38	39	44	13	12
Return to FR 1						
1	97	37	26	109	18	21
1	93	26	16	109	18	18
1	53	29	20	62	11	13
1	110	29	29	106	18	21
1	104	36	27	113	20	21

Gtg	CL	IR	IL	CR	L	R
Hen 74 Condition 1 (FR 1)						
1	153	4	11	146	21	24
1	154	3	24	134	22	21
1	151	7	28	132	21	21
1	153	4	38	119	21	22
1	146	11	18	140	21	23
2	120	33	6	147	21	22
3	59	54	35	77	14	15
4	88	77	58	105	20	21
6	63	71	52	81	16	16
8	81	83	64	103	19	21
10	81	72	86	69	17	17
Hen 74 Condition 2 (FR 5)						
1	46	5	1	49	11	13
1	71	5	2	71	17	16
1	82	6	0	90	18	20
1	82	6	0	89	20	18
1	44	5	0	50	9	11
2	62	28	2	87	16	17
3	33	39	15	59	11	13
4	21	39	10	48	10	11
6	42	41	32	51	13	15
8	28	42	14	53	11	12
10	22	26	12	33	8	6
Return to FR 1						
1	131	8	43	97	20	19
1	118	4	31	92	17	17
1	83	2	13	71	15	12
1	101	2	17	88	15	15
1	138	3	10	132	23	20

Gtg	CL	IR	IL	CR	L	R
Hen 75 Condition 1 (FR 1)						
1	137	21	6	150	22	23
1	149	12	6	157	21	22
1	154	5	8	152	21	22
1	153	3	6	150	22	22
1	161	7	5	162	22	21
2	145	9	0	153	22	23
3	110	49	30	130	19	23
4	89	73	74	87	17	20
6	69	92	69	94	18	17
8	74	84	56	103	19	19
10	89	66	63	90	20	18
Hen 75 Condition 2 (FR 5)						
1	101	2	13	90	21	20
1	102	1	4	99	21	19
1	91	2	1	90	20	20
1	87	0	2	82	21	19
1	82	1	3	80	20	19
2	79	2	4	78	18	19
3	66	7	7	67	17	19
4	53	23	19	55	16	16
6	57	42	44	54	16	16
8	39	55	20	73	15	14
10	41	61	39	60	14	16
Return to FR 1						
1	152	2	24	132	20	22
1	153	5	1	156	23	21
1	159	0	4	153	22	21
1	155	0	13	142	22	22
1	162	1	10	154	23	22

Gtg	CL	IR	IL	CR	L	R
Hen 76 Condition 1 (FR 1)						
1	154	14	3	167	23	21
1	161	3	1	161	22	22
1	153	9	1	165	23	21
1	155	6	3	158	22	23
1	152	8	1	159	22	23
2	117	52	8	162	21	20
3	104	62	27	139	20	20
4	72	101	41	149	19	19
6	62	98	41	119	17	19
8	71	90	45	120	19	19
10	74	90	61	103	20	18
Hen 76 Condition 2 (FR 5)						
1	117	0	0	115	20	20
1	119	0	0	117	19	20
1	115	0	0	116	22	19
1	115	0	0	114	21	20
1	111	1	0	112	20	20
2	89	25	1	114	20	21
3	45	70	7	106	18	17
4	42	71	18	97	16	17
6	17	97	18	95	10	9
8	42	69	34	76	16	15
10	63	50	32	82	18	17
Return to FR 1						
1	152	4	7	151	22	20
1	157	3	5	158	22	23
1	145	10	5	148	23	22
1	152	8	2	160	22	22
1	161	5	3	161	21	23

APPENDIX (*Continued*)

Gtg	CL	IR	IL	CR	L	R
Hen 71 Condition 3 (FR 10)						
1	69	0	0	69	19	19
1	61	1	0	60	19	18
1	61	8	1	61	18	18
1	60	0	0	61	18	18
1	74	2	0	74	17	20
2	68	10	2	75	20	18
3	31	47	16	62	13	13
4	45	29	22	54	15	15
6	38	32	19	51	14	14
8	33	39	9	64	11	14
10	44	31	21	53	16	15
Return to FR 1						
1	141	3	8	135	21	23
1	136	9	14	130	22	23
1	146	1	4	142	23	21
1	144	1	4	140	22	22
1	148	0	2	149	21	21
Hen 71 Condition 4 (FR 15)						
1	51	0	0	55	16	15
1	51	0	0	54	15	16
1	50	0	1	51	17	16
1	56	1	2	56	17	16
1	51	0	0	52	16	16
2	51	5	3	50	16	17
3	31	25	6	49	10	12
4	24	27	10	44	13	14
6	18	32	13	39	9	9
8	24	21	5	42	11	14
10	23	25	7	38	11	11
Return to FR 1						
1	146	7	2	151	21	23
1	139	5	0	144	23	21
1	138	5	6	138	23	22
1	130	8	9	128	21	23
1	140	2	3	140	22	23

Gtg	CL	IR	IL	CR	L	R
Hen 72 Condition 3 (FR 10)						
1	53	4	0	54	15	14
1	54	0	0	55	16	15
1	59	2	0	61	15	15
1	59	3	1	62	17	18
1	58	1	3	58	14	16
2	67	4	1	73	18	19
3	30	34	8	55	15	15
4	33	37	11	58	14	14
6	22	46	12	58	11	12
8	35	35	20	54	14	15
10	21	45	22	44	11	11
Return to FR 1						
1	115	22	8	131	22	21
1	131	14	5	139	22	20
1	128	22	1	150	21	22
1	134	22	4	149	20	21
1	138	9	2	148	22	21
Hen 72 Condition 4 (FR 15)						
1	41	6	1	46	16	16
1	30	18	4	44	12	12
1	25	15	3	38	11	12
1	32	7	0	39	15	13
1	42	6	2	47	16	16
2	36	8	4	41	15	15
3	19	38	7	47	9	6
4	21	30	9	42	11	10
6	7	46	13	44	6	8
8	19	37	11	44	10	10
10	22	30	20	32	12	11
Return to FR 1						
1	125	14	5	136	22	21
1	137	15	9	142	20	21
1	142	5	4	144	21	23
1	146	6	5	146	23	21
1	144	6	8	141	21	20

Gtg	CL	IR	IL	CR	L	R
Hen 73 Condition 3 (FR 10)						
1	78	3	2	80	17	22
1	69	9	1	74	20	19
1	78	2	0	79	20	18
1	54	2	5	49	14	13
1	76	2	4	74	21	17
2	41	19	17	42	11	11
3	23	15	17	25	7	7
4	15	17	7	26	7	6
6	13	14	11	14	6	3
8	28	17	9	38	11	8
10	6	6	3	6	2	2
Return to FR 1						
1	104	40	29	114	20	22
1	98	42	25	115	19	22
1	101	46	23	125	21	19
1	103	39	30	114	20	22
1	126	25	24	131	21	21
Hen 73 Condition 4 (FR 15)						
1	39	6	2	4	14	11
1	23	4	3	26	8	7
1	21	5	6	17	9	9
1	11	0	6	5	2	3
1	42	4	4	42	14	4
2	6	5	4	8	3	3
3	18	32	15	36	8	12
4	8	12	9	12	3	2
6	7	21	4	22	3	5
8	20	19	13	29	12	10
10	23	25	16	31	10	9
Return to FR 1						
1	130	18	16	132	20	22
1	115	34	15	134	22	21
1	112	41	10	143	22	19
1	95	49	23	123	19	21
1	120	31	7	147	21	22

Gtg	CL	IR	IL	CR	L	R
Hen 74 Condition 3 (FR 10)						
1	54	1	0	56	17	18
1	36	1	0	38	12	11
1	43	3	1	42	13	13
1	8	0	1	8	2	2
1	29	1	0	31	9	8
2	36	6	4	39	12	12
3	11	22	9	24	6	5
4	6	11	1	18	4	2
6	5	8	4	9	2	1
8	3	19	1	18	2	4
10	7	7	1	12	4	4
Return to FR 1						
1	70	27	5	91	16	16
1	110	19	25	106	20	20
1	128	12	30	110	20	22
1	84	16	13	86	16	13
1	117	8	13	114	19	19
Hen 74 Condition 4 (FR 15)						
1	46	1	1	45	14	15
1	45	2	0	48	15	14
1	50	0	1	47	16	16
1	42	2	0	45	14	15
1	29	12	0	42	13	15
2	8	27	5	30	7	6
3	28	23	17	34	11	11
4	15	25	12	29	8	8
6	16	17	9	25	7	8
8	10	18	2	26	7	8
10	16	21	2	39	10	9
Return to FR 1						
1	105	18	17	104	19	19
1	112	25	14	123	21	22
1	130	14	10	134	22	19
1	122	11	35	96	19	20
1	134	7	14	127	21	21

Gtg	CL	IR	IL	CR	L	R
Hen 75 Condition 3 (FR 10)						
1	57	7	0	65	19	17
1	52	9	0	60	16	18
1	53	3	1	59	16	18
1	54	7	0	61	17	17
1	63	1	0	65	19	18
2	51	9	2	59	16	17
3	35	20	1	53	14	14
4	15	37	8	45	6	7
6	24	33	24	35	12	10
8	33	18	16	35	13	15
10	35	22	16	40	13	16
Return to FR 1						
1	143	9	12	137	21	20
1	154	3	7	153	22	23
1	159	1	5	154	22	23
1	162	2	4	159	21	23
1	165	1	9	156	22	22
Hen 75 Condition 4 (FR 15)						
1	53	0	1	57	16	17
1	56	0	0	57	16	16
1	50	3	0	50	18	16
1	46	4	0	49	15	13
1	55	1	1	53	16	16
2	38	6	1	45	15	14
3	14	31	2	43	7	8
4	7	23	1	25	5	6
6	4	10	5	11	3	3
8	19	21	10	30	10	10
10	32	19	19	32	15	13
Return to FR 1						
1	148	9	8	148	20	23
1	155	2	3	153	23	20
1	158	0	5	151	22	23
1	158	2	5	155	21	22
1	160	0	3	157	22	23

Gtg	CL	IR	IL	CR	L	R
Hen 76 Condition 3 (FR 10)						
1	75	2	7	69	18	18
1	75	1	0	78	20	20
1	78	1	1	78	19	18
1	83	0	4	78	19	19
1	84	1	0	84	18	19
2	80	4	0	87	20	20
3	47	40	11	74	16	16
4	43	46	24	67	16	16
6	41	51	42	49	16	19
8	45	36	16	66	17	17
10	49	36	27	57	16	16
Return to FR 1						
1	146	10	4	150	21	23
1	149	16	5	159	21	24
1	159	9	9	159	20	23
1	159	6	5	159	21	23
1	165	3	6	162	21	23
Hen 76 Condition 4 (FR 15)						
1	60	7	0	65	17	17
1	57	0	0	55	17	16
1	57	2	4	55	18	17
1	58	0	0	60	15	16
1	58	1	0	59	19	17
2	47	11	1	56	19	13
3	30	31	11	50	15	12
4	21	38	7	53	12	15
6	19	34	22	30	9	9
8	30	27	16	39	13	13
10	40	24	20	41	15	14
Return to FR 1						
1	143	12	10	147	23	21
1	140	14	7	148	21	22
1	138	19	3	154	24	21
1	148	13	4	157	23	21
1	156	7	4	158	21	23

APPENDIX (*Continued*)

Gtg	CL	IR	IL	CR	L	R
Hen 71 Condition 5 (FR 25)						
1	27	0	0	27	13	11
1	32	0	0	33	12	13
1	34	0	0	83	13	12
1	34	0	0	33	14	13
1	32	0	1	32	15	15
2	24	5	1	27	13	13
3	13	20	5	27	8	9
4	8	26	3	31	6	9
6	15	20	11	24	8	8
8	13	23	10	26	6	7
10	15	14	4	26	9	11
Return to FR 1						
1	142	5	1	146	21	23
1	137	6	0	144	21	24
1	137	8	2	145	21	23
1	140	3	4	139	21	22
1	132	9	3	140	21	21
Hen 71 Condition 6 (FR 40)						
1	19	0	0	19	11	9
1	19	0	0	19	10	9
1	21	0	0	21	10	8
1	14	0	1	15	10	8
1	16	0	0	16	12	14
2	19	2	0	21	9	12
3	1	11	0	9	1	5
4	7	14	5	15	4	7
6	2	6	0	8	2	2
8	9	15	3	18	5	7
10	10	13	1	21	6	5

Gtg	CL	IR	IL	CR	L	R
Hen 72 Condition 5 (FR 25)						
1	20	1	0	11	6	
1	29	0	0	27	1	12
1	25	0	0	24	8	10
1	26	3	0	28	9	12
1	24	2	0	28	11	11
2	25	0	0	29	13	13
3	16	12	3	25	11	9
4	18	14	6	27	10	10
6	14	16	11	18	7	7
8	12	13	6	21	8	6
10	8	13	4	17	5	5
Return to FR 1						
1	139	6	5	141	21	22
1	126	10	13	121	21	19
1	132	7	10	130	20	22
1	138	5	3	138	21	22
1	142	6	5	142	21	20
Hen 72 Condition 6 (FR 40)						
1	16	0	0	14	10	8
1	14	1	0	13	8	4
1	14	3	0	16	9	10
1	15	1	0	16	8	10
1	15	0	0	16	7	8
2	17	1	0	18	9	10
3	12	3	0	13	6	7
4	7	4	7	6	5	4
6	6	5	4	7	1	5
8	7	6	1	11	5	5
10	7	8	10	5	4	4

Gtg	CL	IR	IL	CR	L	R
Hen 73 Condition 5 (FR 25)						
1	6	4	1	7	3	3
1	21	7	1	26	12	12
1	8	7	0	11	4	4
1	13	3	3	13	4	5
1	16	6	3	16	5	6
2	2	1	1	3	0	2
3	0	1	0	3	0	2
4	2	8	2	6	2	1
6	5	10	1	12	3	6
8	10	9	4	19	7	6
10	2	2	3	2	2	1
Return to FR 1						
1	107	32	14	125	20	21
1	83	46	11	117	20	20
1	100	40	22	119	21	19
1	89	49	10	127	20	19
1	102	45	11	134	21	19

Gtg	CL	IR	IL	CR	L	R
Hen 74 Condition 5 (FR 25)						
1	22	3	2	25	11	9
1	9	4	0	11	4	4
1	20	4	1	25	10	9
1	10	5	1	15	7	4
1	13	10	6	17	8	10
2	0	8	0	7	0	2
3	4	5	3	7	3	3
4	7	9	7	10	4	4
6	7	15	5	15	4	3
8	10	7	6	12	2	4
10	5	8	7	6	2	3
Return to FR 1						
1	125	13	7	130	19	22
1	94	4	5	93	14	16
1	143	3	16	132	22	21
1	130	5	25	112	20	19
1	129	8	34	102	21	19
Hen 74 Condition 6 (FR 40)						
1	12	1	0	10	7	5
1	3	3	0	6	3	0
1	12	4	1	16	7	9
1	7	3	0	10	6	4
1	12	0	5	10	7	7
2	5	10	3	12	4	4
3	3	11	2	12	1	2
4	0	7	2	2	0	0
6	7	14	7	13	4	3
8	4	8	3	7	2	3
10	7	7	5	10	3	3

Gtg	CL	IR	IL	CR	L	R
Hen 75 Condition 5 (FR 25)						
1	22	0	1	19	13	10
1	6	0	0	10	3	4
1	27	0	0	25	13	12
1	23	0	0	23	12	12
1	19	0	0	18	7	9
2	7	4	1	9	3	4
3	8	6	1	12	6	6
4	9	7	3	13	5	5
6	7	8	4	11	3	5
8	11	5	3	13	6	6
10	7	6	4	9	3	3
Return to FR 1						
1	162	0	2	161	23	21
1	83	0	0	83	12	11
1	159	1	6	155	21	23
1	160	0	1	154	22	21
1	150	4	10	142	22	23
Hen 75 Condition 6 (FR 40)						
1	6	0	2	5	2	3
1	9	0	1	7	2	4
1	4	1	0	7	3	2
1	10	0	0	7	4	4
1	10	0	0	7	2	6
2	8	2	1	8	6	3
3	2	4	0	8	2	6
4	3	5	5	4	3	4
6	2	3	1	4	0	1
8	1	1	1	3	0	1
10	8	4	1	12	6	4

Gtg	CL	IR	IL	CR	L	R
Hen 76 Condition 5 (FR 25)						
1	29	0	0	31	13	13
1	27	1	0	26	12	12
1	29	0	0	28	12	10
1	30	0	1	27	13	12
1	26	1	0	27	14	11
2	11	14	1	26	8	9
3	8	17	6	19	3	0
4	16	16	12	20	5	7
6	32	0	1	33	13	13
8	16	7	4	20	7	10
10	15	6	9	13	8	6
Return to FR 1						
1	138	13	4	146	22	21
1	138	13	0	151	23	20
1	137	17	1	154	23	22
1	133	26	3	154	20	21
1	135	20	1	153	22	23
Hen 76 Condition 6 (FR 40)						
1	19	0	0	18	9	11
1	15	0	0	15	11	8
1	18	0	2	16	9	7
1	20	0	0	20	8	7
1	18	0	1	17	7	8
2	20	2	1	20	10	7
3	2	16	2	14	2	0
4	8	7	8	5	1	0
6	4	9	4	11	3	3
8	10	9	2	18	7	10
10	17	6	12	10	6	6

APPENDIX (*Continued*)

Gtg	CL	IR	IL	CR	L	R
Return to FR 1						
1	138	1	0	136	21	21
1	131	2	1	136	22	22
1	136	4	3	137	20	22
1	143	1	1	143	19	23
1	141	2	2	139	21	23
Hen 71 Condition 7 (FR 1)						
1	139	2	5	134	22	21
1	142	2	4	139	22	22
1	126	3	6	125	21	21
1	130	4	7	127	21	23
1	128	3	4	127	22	21
2	101	34	12	122	22	20
3	90	51	21	119	21	20
4	79	57	46	89	18	19
6	80	67	44	101	17	21
8	90	52	41	99	20	19
10	84	58	52	90	18	20

Gtg	CL	IR	IL	CR	L	R
Return to FR 1						
1	152	5	8	148	22	22
1	137	4	7	136	20	22
1	141	6	0	149	22	23
1	139	8	4	143	22	20
1	147	5	4	148	22	20
Hen 72 Condition 7 (FR 1)						
1	139	14	5	150	21	22
1	142	11	4	148	21	23
1	132	20	9	146	20	21
1	134	11	14	132	22	21
1	133	16	1	148	20	21
2	120	35	19	134	20	22
3	83	77	27	133	20	21
4	73	89	44	119	21	20
6	71	93	60	103	18	19
8	72	88	37	123	19	17
10	70	91	36	125	21	20

Gtg	CL	IR	IL	CR	L	R
Hen 73 Condition 7 (FR 1)						
1	98	46	28	115	20	21
1	102	42	11	131	20	21
1	84	60	31	116	19	20
1	93	49	28	114	19	20
1	106	46	23	125	19	18
2	71	79	44	105	21	19
3	68	82	64	85	18	17
4	65	86	58	92	18	19
6	64	88	56	94	19	20
8	74	68	50	93	20	20
10	62	86	58	90	18	18

Gtg	CL	IR	IL	CR	L	R
Return to FR 1						
1	133	9	9	132	22	21
1	60	12	0	69	12	9
1	123	9	10	122	20	23
1	121	9	13	119	19	20
1	138	5	23	120	22	19
Hen 74 Condition 7 (FR 1)						
1	152	3	27	124	22	21
1	149	6	23	131	21	22
1	142	8	39	109	21	23
1	141	8	39	109	21	22
1	139	12	40	110	21	19
2	79	76	66	90	17	22
3	67	61	58	70	16	17
4	95	56	73	78	17	19
6	90	68	75	83	19	18
8	107	50	96	61	20	17
10	93	66	83	73	18	18

Gtg	CL	IR	IL	CR	L	R
Return to FR 1						
1	161	0	6	155	22	23
1	160	0	7	152	21	23
1	156	2	0	158	23	22
1	162	3	0	158	22	22
1	163	0	2	159	23	22
Hen 75 Condition 7 (FR 1)						
1	162	0	1	159	23	21
1	161	0	6	154	21	22
1	152	0	5	145	22	22
1	162	1	4	157	22	22
1	157	1	6	153	21	21
2	131	33	18	145	21	22
3	85	78	26	139	20	20
4	75	82	58	97	19	17
6	75	83	53	102	20	19
8	78	84	40	121	19	19
10	73	87	56	104	19	18

Gtg	CL	IR	IL	CR	L	R
Return to FR 1						
1	129	22	3	148	22	19
1	142	18	3	157	22	22
1	140	16	5	148	22	21
1	143	18	6	157	20	23
1	152	12	0	166	23	22
Hen 76 Condition 7 (FR 1)						
1	131	39	1	168	20	22
1	147	24	1	168	23	21
1	135	35	2	170	22	22
1	137	31	5	161	22	23
1	142	31	1	169	22	21
2	91	82	21	149	21	21
3	61	108	29	140	19	16
4	50	123	34	141	19	19
6	56	120	51	126	19	18
8	76	94	32	140	20	20
10	76	100	36	140	20	20